

- [54] VACUUM COATING APPARATUS  
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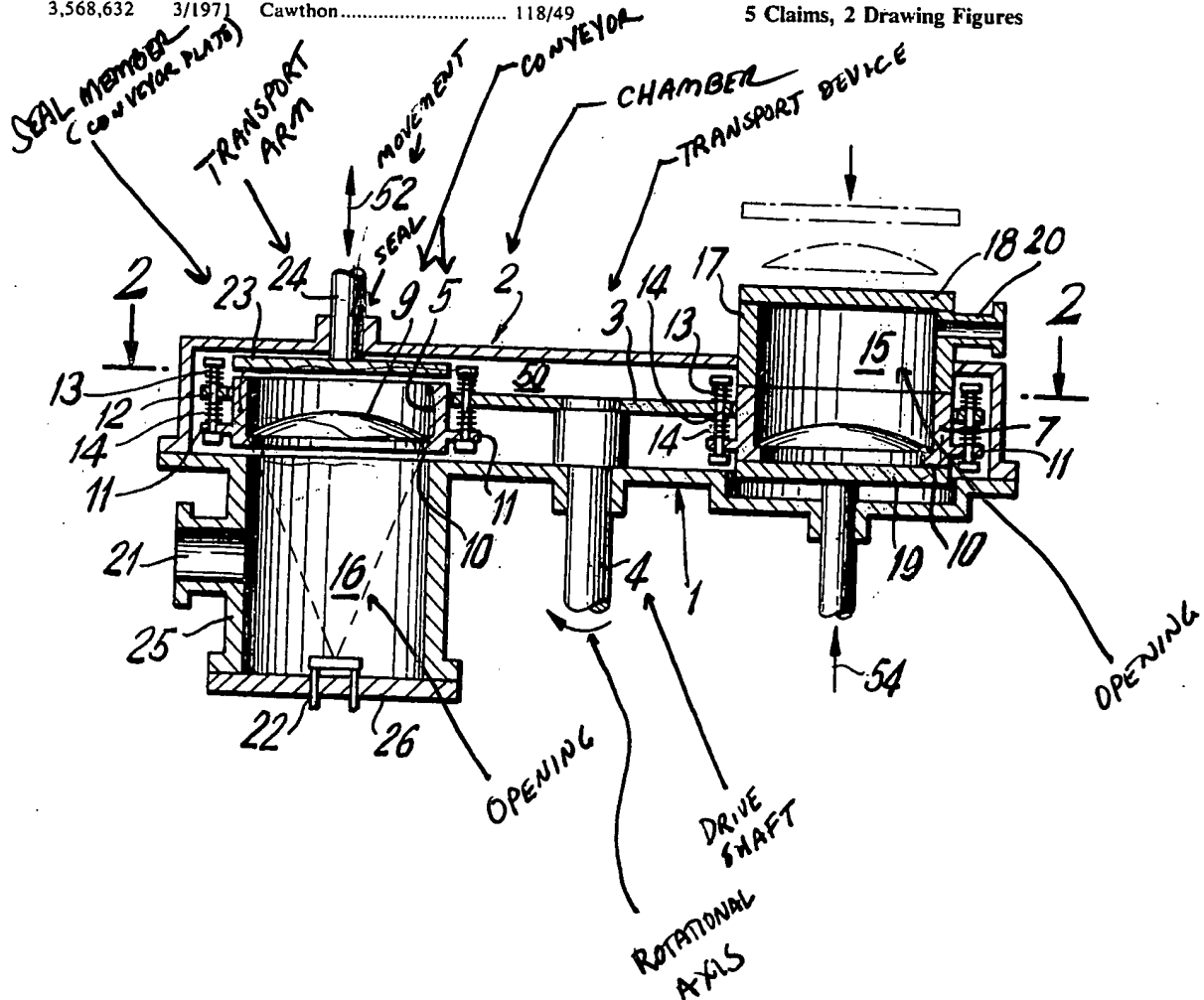
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[57] ABSTRACT

A vacuum coating apparatus for coating various products comprises a housing which includes a fixed part and a rotatable cover part which together define a closed gas sealable housing chamber which may be evacuated. A plurality of product supports are carried on the movable part of the housing at spaced locations and they are movable to present them at various operating stations. One of the operating stations preferably includes a gas sealable coating chamber which is communicable with the gas sealed housing chamber and it is provided with separate means for evacuating the coating chamber. Movable sealing means are located at at least one of the stations for sealing the coating chamber and isolating it from the housing chamber. Similarly, a loading chamber is advantageously located at a separate station and is separately communicable with the housing chamber or it may be isolated from the housing chamber and separately evacuated.

5 Claims, 2 Drawing Figures



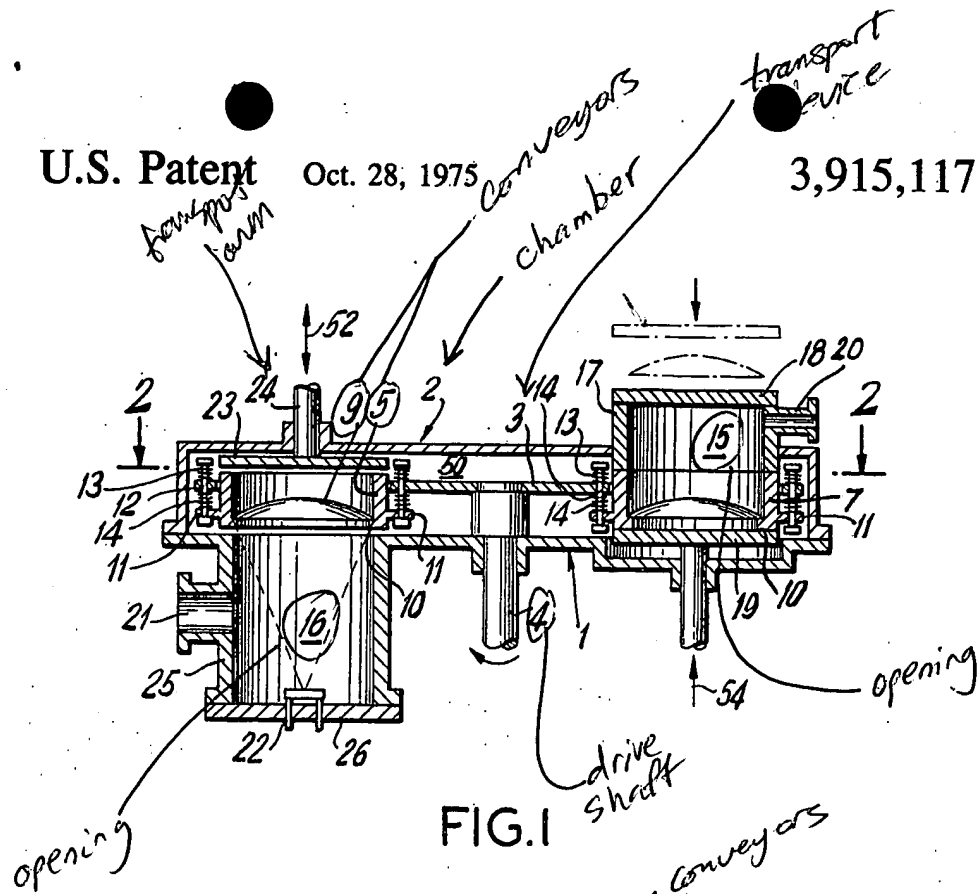


FIG. 1

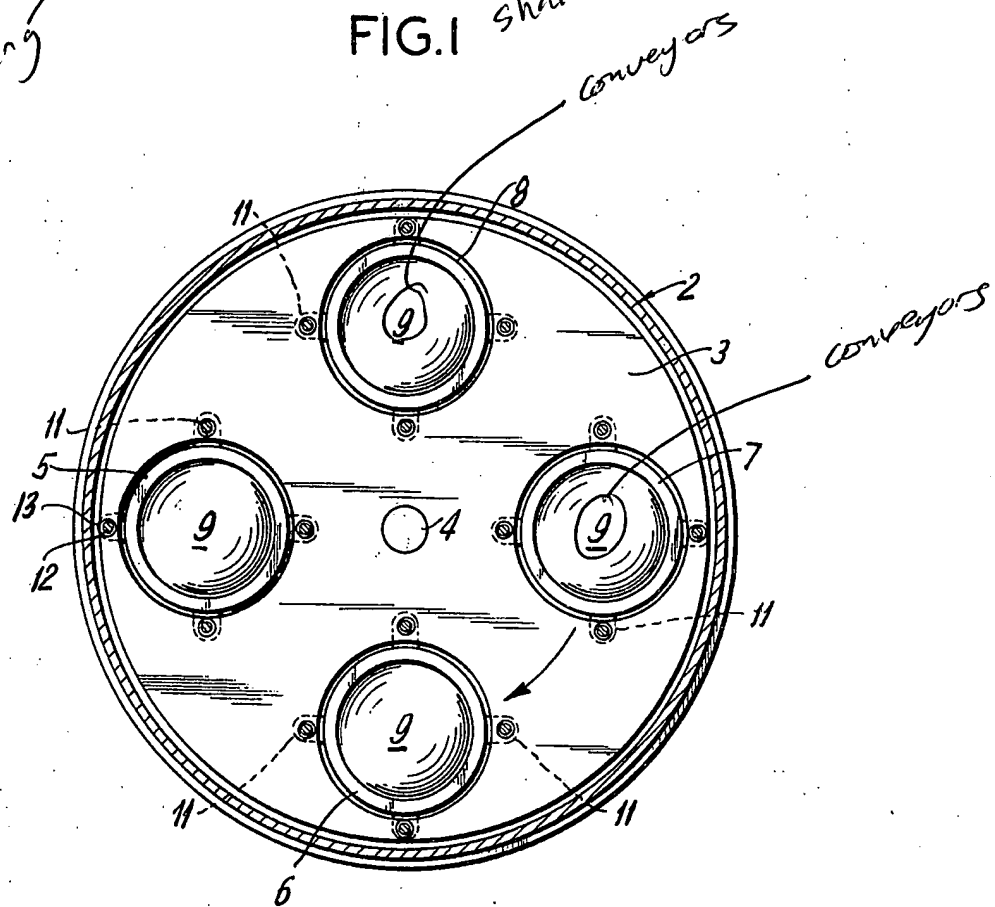


FIG. 2

## VACUUM COATING APPARATUS

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

This invention relates in general to the construction of a vacuum coating apparatus for coating various products and in particular to a new and useful vacuum coating apparatus which has a plurality of different working stations for inserting and removing as well as for processing products and which includes a rotatable transport device for the products carried on supports which are locatable in the main chamber which is capable of being separately evacuated from one or more separate stationary chambers.

## 2. Description of the Prior Art

The present invention deals particularly with vacuum coating apparatus wherein various articles or products must be inserted into an evacuation chamber and subsequently coated after they are first heated for the purpose of cleaning the surfaces to be coated and thereafter coated in an evacuated chamber for example by evaporation or cathode sputtering and are subsequently cooled down and removed from the chamber. There are known vacuum coating devices in which the products to be coated are continuously charged into a vacuum chamber, treated by evaporation and then discharged again by means of a transport device. For example, plastic film tapes and reflector surfaces are metallized in a continuous operation plant.

The disadvantages of the known devices is that their construction is very expensive and they are usable generally only for particular products to be coated and which have predetermined shapes. Often in the insertion and removal of the products to be coated into the coating chamber results in sealing difficulties which is solved only by provision of expensive air-lock constructions.

## SUMMARY OF THE INVENTION

The present invention provides a vacuum coating apparatus which is reliable in service and can be constructed at lower expenses than the known devices and make it possible to carry out different treatments of the products in vacuum chambers which are hermetically separable from each other.

In accordance with the invention there is provided a vacuum coating device which has a plurality of different working stations or operating stations which permit the air-tight insertion and removal and also the processing of the products. The device comprises a movable preferably rotatable transport device for the products which are located in a main chamber which is capable of being evacuated. At least one of the operating stations includes a separate chamber for coating for example which is designed to be aligned with a support structure carried by the movable part of the housing defining the main chamber. The arrangement is such that the coating chamber may be isolated from the main chamber and separately evacuated during the treatment. With the construction of the invention substantially all of the lift and swiveling valves which are necessary particularly in plants which comprise a plurality of mutually separable vacuum chambers can be omitted due to the invention and the costs of the installation therefore can be substantially reduced.

Accordingly it is an object of the invention to provide an improved coating device wherein movable housing means defines a main chamber and the movable portion carries a plurality of separate supports for articles to be processed which may be moved into alignment with one or more separate sealable chambers for example for coating or removing the objects which may be separately evacuated and which may be connected to the main chamber of the housing or isolated therefrom.

A further object of the invention is to provide a coating apparatus which is simple in design, rugged in construction and economical to manufacture.

For an understanding of the principles of the invention, reference is made to the following description of a typical embodiment thereof as illustrated in the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a transverse sectional view of a vacuum coating apparatus constructed in accordance with the invention; and

FIG. 2 is a section taken along the line 2—2 of FIG. 1.

## GENERAL DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings in particular the invention embodied therein comprises housing means which includes a bottom part 1 and a cap-shaped top part 2 which together define a closed main sealable chamber 50. A rotatable article or product support or transport table 3 is affixed to a shaft 4 which is rotatable in and hermetically sealed with the bottom housing part 1. The transport table 3 is provided with a plurality of working stations and in the embodiment shown it includes four separate working stations 5, 6, 7 and 8. Each working station has support means for supporting a workpiece 9 or product to be coated. For this purpose the support means comprises an inwardly directed shoulder 10 which carries the workpieces or the supports therefor 9 with the products to be coated which as shown in the embodiment of the drawings comprises a cap-like structure.

In accordance with a feature of the invention the support structures 5, 6, 7 and 8 are resiliently carried on the table 3 by means of pins 12 which are supported by top and bottom springs 13 and 14 on the table 3. For this purpose each of the supports 9 are provided with radial collars or extensions 11 forming eyelets through which the bolts 12 are directed. The construction is such that the supports 9 may move in axial directions as indicated by the double arrow 52.

By rotating the shaft 4 the individual supporting rings 5, 6, 7 and 8 can be brought successively into different working stations or operating stations. A plurality of such operating stations are provided and in the embodiment shown one of the working stations comprises a first chamber 15 and another comprises a second chamber 16 which may be separately evacuated and which may be hermetically closed relative to the main chamber 50.

Preferably at least one chamber such as the chamber 15 serves for the insertion and removal of supports 9. This working chamber is formed as soon as one of the support structures 5, 6, 7 or 8 which are in the form of rings is aligned with a fixed part 17 which is connected

into the top cover wall 2 of the housing and it communicates with the main chamber 50. In the embodiment shown the ring part 7 aligns with the stationary part 17. The stationary part 17 includes a cover portion 18 and the chamber 15 is connectable to a connection or conduit 20 which is connected to an evacuation pump or an aeration pump (not shown).

When the chamber 15 is to be separately sealed from the main chamber 50 a sealing plate 19 which is carried on the housing bottom portion 1 is displaced axially in the direction of arrow 54 to close against the bottom of the support 9 so that when the cover 18 is in place the chamber 15 may be separately isolated from the main chamber 50 and evacuated through the connection 20. It is possible while the main chamber 50 is still evacuated to open the working chamber 15 and place the products to be coated for example a support 9 carrying lenses to be coated in the supporting structure 7. The supporting structure 9 as well as the supporting structure 7 may be designed in accordance with the type of products which are normally handled. For example a plate having openings in which the lenses are positioned or having an underside for securing the lenses thereon. Support 9 can also be replaced by a single object for example a mirror body to be coated.

After the working chamber 15 is closed and reevacuated and upon lowering of the valve plate 19, the supporting ring 7 carrying the products to be treated can be displaced into the next working station. Such a working station may be equipped for example with means for deposition by evaporation such as chamber 16 as shown in FIG. 1. The working chamber 16 is provided with a separate evacuation connection 21 and it is equipped with one or more evaporation sources 22 of known construction. As soon as a support ring 5, 6, 7 or 8 is moved into alignment with the evaporation station, the space in which the deposition by evaporation takes place is evacuated and the deposition can be carried out.

Should it be necessary during the evaporation stage to close the evaporation chamber relative to the main chamber 50 or perhaps to close it relative to other working chambers which may require different gas pressures for example such as the air lock chamber 15, the evaporation chamber 16 can also be hermetically closed relative to the main chamber 50. This is accomplished by movement of a plate 23 into pressure engagement with the supporting ring 5 which is positioned in the evaporation station shown in FIG. 1. An air-tight vacuum chamber 16 is formed by supporting ring 5 and the part 25 of the chamber 16 and a removable bottom 26. Suitable seals are provided between these parts to insure the air tightness. After the coating operation is finished the plate 23 can be removed from the ring 5 and the ring thus becomes ready for further displacement.

In a similar manner hermetically closable working chambers can be formed for any other working stations which are desired or necessary. Such stations may be equipped for further depositing by evaporation or cathode sputtering or for heating or cooling of the substrates to be coated or of the deposited layers on the substrate in order to bombard the surfaces to be coated with ions or electrons and the like.

In order to remove the finish-treated products from the apparatus one of the working stations may be designed as an air lock chamber and it is useful to provide

that the same chamber will be used for insertion and removal as shown in respect to the chamber 15.

The number of the required working stations or the working chambers and their distribution and the operational steps which are carried out at each station depends not only on the kind of operation to be performed at each step but also on the periods of time necessary for this purpose. Advantageously approximately the same period of time is provided for each of the working stations since the longest of these periods determines the station time which in a continuous operation must be observed for consecutively advancing the treated products from one station to the next.

The main chamber is evacuated either through a separate evacuation connection or through one of the working chambers which has its own evacuation connection and provided such evacuation is possible with respect to the operations which are being performed.

The inventive arrangement has the particular advantage of being very flexible. In accordance with this requirement most various working chambers can be flanged to the main chamber if corresponding separation flanges are provided. It is useful if possible to arrange the whole equipment of one working chamber on a single flange plate such as the plate 26 as shown in FIG. 1 so that it is sufficient to replace only this plate.

It is not absolutely necessary of course to provide the supporting structures in an annular form as shown in the present example. Such structures may comprise rectangular cross section if desired. In the drawing a resilient mounting of the supporting structures is shown but instead the transport table 3 itself may be mounted for resilient upward and downward axial displacement. For such purpose the bushing of the shaft 4 would be designed for rotary as well as axial displacement movement. The resilient support of the support structures on the working table offers the best possible advantages both in respect to communication with the upper and lower side of the housing main chamber 50.

While a specific embodiment of the invention has been shown and described in detail to illustrate the application of the principles of the invention, it will be appreciated that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A vacuum coating apparatus for coating various products, comprising housing means having an interior gas sealable housing chamber which may be evacuated, means defining a plurality of operating stations adjacent said housing, at least one movable member in said housing movable to each of said operating stations, a plurality of product supports carried on said movable member at spaced locations, at least one operating station including a gas sealable coating chamber which is communicable with said gas sealed housing chamber and which has connection means for evacuating said coating chamber, movable sealing means at said at least one operating station for sealing said coating chamber and isolating it from said housing chamber, said product support means comprising ring members, said gas sealing coating chamber comprising a cylindrical housing alignable with each ring member, and said movable sealing means comprising a plate member engageable on the opposite side of said ring member from said gas sealable coating chamber and being engageable with the end of said ring member to seal it.

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2. A vacuum coating apparatus according to claim 1, wherein said product supports are resiliently supported on said movable member.

3. A vacuum coating apparatus according to claim 1, including an additional gas sealable chamber at one of said operating stations having an additional connection means for evaporating said additional gas sealable chamber, said gas sealable chamber comprising a cylindrical member having a removable cover at the exterior of said housing for loading and unloading products therethrough.

4. A vacuum coating apparatus comprising a housing having a bottom plate portion, a top cover portion covering said bottom plate portion and defining a main sealable chamber therein, a rotatable table in said housing main chamber, means connected to said table to rotate said table sealed with said housing member, a plurality of ring supports spaced circumferentially around said table and having means for supporting a product to be coated therein, and each being aligned with an annular top ring surface adjacent said cover and an annular bottom ring surface adjacent said bottom plate of said housing, at least one coating chamber

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connected to said bottom plate of said housing and opening into said main chamber, said coating chamber having a coating chamber evacuation connection for evacuating said coating chamber, resilient means resiliently supporting said table and the associated ring supports for axial displaceable movement toward and away from said coating chamber, and a cover plate mounted on said cover and being displaceable toward said ring to engage and seal said ring and displace it into sealing engagement with said coating chamber.

5. An apparatus according to claim 4, including at least one second chamber connected to said cover and having an annular edge alignable over the annular end of said ring support structures, a separate additional evaporation connection connected to said additional chamber for evacuating said additional chamber and a second sealing plate displaceably carried on said bottom plate of said housing and movable toward said sealing ring which is aligned with said additional sealing chamber to displace said ring toward said chamber and to seal the end thereof in respect to said main chamber.

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